

**Original Article****Research Concerning the Phenotypical Variability of Spruce Trees within Recovered Forestry Areas during 1995 - 2005, from Ghiurghiu Mountains****NĂSTĂSESCU Vasile Valentin\*, Dumitru ZAHARIA***University of Agricultural Sciences and Veterinary Medicine Cluj - Napoca, Mănăştur St., No. 3 - 5,  
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**Abstract**

This study aimed to deliver solutions for the restoration of the anthropically and entropically affected spruce trees stands from the Ghiurghiu Mountains in the areas located the counties of Harghita and Mureş during 2006 and 2011. There were identified and selected the experimental areas, anthropically and entropically affected. Measurements were performed (from 10<sup>th</sup> to 16<sup>th</sup> years of age), GPS coordinates identified, and data were processed. Maps (1 : 20,000 scale) were performed and experimental variants were isolated by circular and rectangular 200 m<sup>2</sup> areas. Significant differences were identified in development and restoring of the areas anthropically and entropically affected (consistency, composition, achievement of the natural fundamental type of forest) from the studied forests, administered by forest offices or not administered areas, whatever ownership form or property. Significant differences were also identified concerning the phenotypical variability of the researched traits (height, diameter, crown, lujeri, needles) in terms of provenience and position on versant. From our analyzes resulted that in areas administered by forest offices it was proposed and promoted the natural fundamental type of forest. In not administered areas the forests, the fundamental type of forest could not be promoted and put into practice and due to this reason, it is considered that those forest would become derivative forests with inferior type of productivity.

**Keywords:** spruce, stands, height, diameter, crown, needle

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**1. Introduction**

The anthropic and entropic impact on forestry vegetation identified in Ghiurghiu Mountains during 1995 - 2005, that affected large forestry areas, remediation and development of stands from these areas, represent a basic conditions concerning the forest continuity and quality [1, 3]. It is well known that natural ecosystems, forestry ones especially, create conditions for development of the social system [4, 7].

Also, the forestry management and preservation ways will influence the resources supply by short medium and long terms [6].

As consequence, we can find that human society may affect the self-regulation and self-organizing of forestry systems.

Correct identification in time of the negative intervention of the human factor on the forestry ecosystems, creates the premises for the correction solutions by implementation of required measures [2, 5, 7]. The aim of this study is to deliver solutions for the restoration of the anthropically and entropically affected spruce trees stands from the Ghiurghiu Mountains.

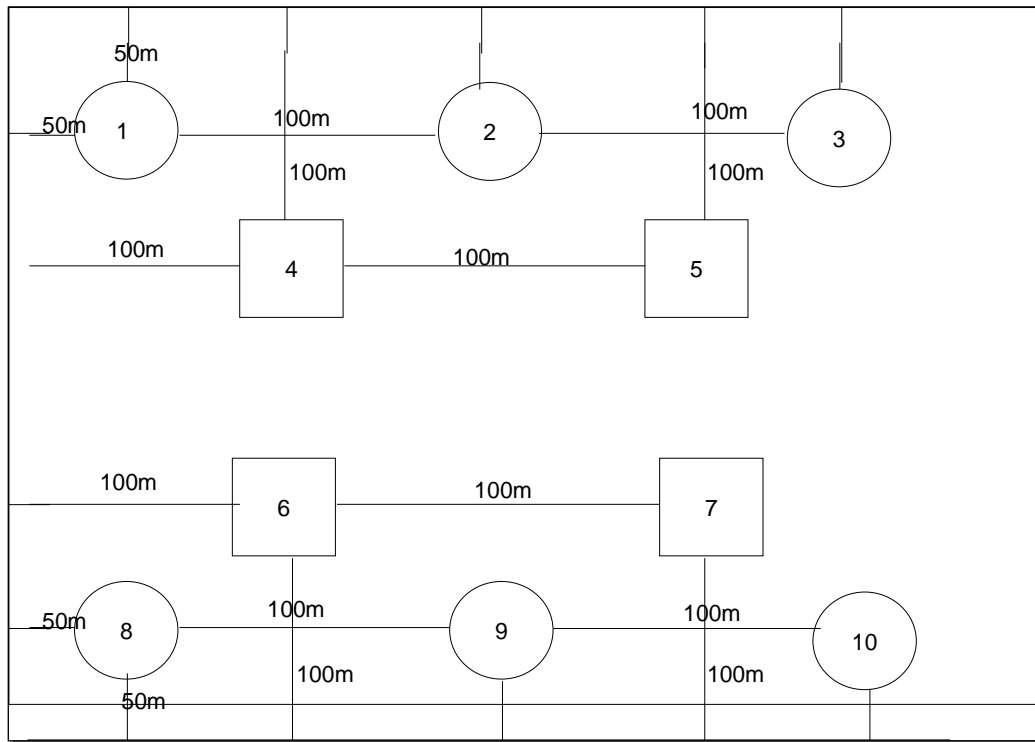
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## 2. Material and Method

The research was performed in spruce forests located within the administrative areas of the counties from Harghita (Remetea, Toplița, Joseni, Ciumani, județul), and Mureș (Răstolița, Lunca Bradului și Stânceni), during 2006 and 2011. There were identified and selected the experimental areas

(fig. 1), anthropically and enthropically affected. Two experimental factors were taken into consideration, tree position on slope and tree provenience, respectively. The data were statistically processed (Duncan and Tuckey tests) in order to emphaize the consistency in time of the analyzed data.



**Figure 1.** The pattern of the placement of the research areas

### 3. Results and Discussions

The analysis of variance for height of spruce trees in natural and artificial regeneration, in the series of experiments type  $A \times B \times Y$  (2006-2011). The tree height increased from 10<sup>th</sup> to 16<sup>th</sup> plantation years. Concerning the annual height increase, the most important influence was identified in experimental factors, while the interaction between these factors recorded lower influence (table 1).

Because the interaction between both experimental factors had significant effects on the variability of the experimental data (tree height), the synthesis of the results was necessary to be emphasized (table 2).

The diameter of the trees annually increased in the mean time with their height during experimental time interval, 2006 – 2011. The average of the data recorded different values, function of specific conditions concerning anthropically and entropically actions.

The influences of the both experimental considered factors (slope position and provenience of the trees) emphasized (table 3). The most important influence of the tree diameter was identified in the tree provenience, while the position of the slope and the interaction of both experimental factors had less importance.

Table 1. Analysis of variance for height of spruce trees in natural and artificial regeneration, in the series of experiments type  $A \times B \times Y$  (2006 - 2011)

Source of variation	SS	DF	$s^2$	F Test			
				Versus $s^2_E$		Versus $s^2_{A \times B \times Y}$	
Total	1170.58	323					
Replications	0.61	12					
Years	361.55	5	72.309	2509.79	>2.21	1333.34	>2.45
A x years ( $A \times Y$ )	0.63	5	0.126	4.36	>2.21	2.32	<2.45
B x years ( $B \times Y$ )	2.65	40	0.066	2.30	>1.39	1.22	<1.69
A position on slope	93.44	1	93.444	3243.38	>3.84	1723.07	>4.08
B provenience	690.27	8	86.284	2994.86	>1.94	1591.04	>2.18
A x B	13.38	8	1.673	58.07	>1.94	30.85	>1.18
A x B x years ( $A \times B \times Y$ )	2.17	40	0.054	1.88	>1.39		
Error	5.88	204	0.029				

Table 2. Effect of provenance and position of the slope on the height of spruce trees in natural and artificial regeneration in the series of experiences bifactorial type  $A \times B \times Y$  (2006-2011)

In the series of experiences on factorial type A x B x years (2000-2011)								
	Position on slope		Inferiour half of the versant		Superiour half of the versant		Mean of provenance	
Provenance								
Fâncel		9.5	a		7.7	gh	8.6	AB
Gâtea		9.3	ab		8.1	ef	8.7	A
Lăpușna		9.1	bc		7.9	fg	8.5	AB
Gudea		8.9	c		7.9	fg	8.4	B
Sălard		8.5	d		7.2	i	7.8	C
Iod		8.3	de		7.6	h	8.0	C
Niraj		8.1	ef		7.8	gh	7.9	C
Remetea		5.4	j		4.0	l	4.7	D
Joseni		5.4	j		4.5	k	4.9	D
Media / Mean		8.0	M		7.0	N		

DS/SD<sub>5%</sub> for two means of A(position on splope = 0.1

DS/SD<sub>5%</sub> for two means of B (provenience) = 0.3 – 0.3

DS/SD<sub>5%</sub> for two means  $A \times B$  = 0.4 – 0.5

N.B. The difference between any two values, followed by at least a common letter, is not significant

Table 3. Analysis of variance for diameter of spruce trees in natural and artificial regeneration, in the series of experiments type  $A \times B \times Y$  (2006 - 2011)

Source of variation	SS	DF	$s^2$	F Test	
				Versus $s^2_{A \times B \times Y}$	
Total	1408.81	323			
Replications	1.00	12			
Years	890.46	5	178.093	940.80**	>2.45; 3.51
A x years ( $A \times Y$ )	0.85	5	0.171	0.90	<2.45
B x years ( $B \times Y$ )	42.09	40	1.052	5.56**	>1.69; 2.11
A position on slope	2.76	1	2.759	14.58**	>4.08; 7.31
B provenience	433.51	8	54.188	286.26**	>2.18; 2.99
A x B	16.92	8	2.115	11.17**	>1.18; 2.99
A x B x years ( $A \times B \times Y$ )	7.57	40	0.189		
Error	13.65	204	0.067		

DS/SD<sub>5%</sub> for two means  $A \times B$  = 0.4 – 0.5

N.B. The difference between any two values, followed by at least a common letter, is not significant

No significant influence of the experimental factors was determined concerning the tree position on the versant (table 4). In the mean time with tree

ageing, from the moment of natural of regeneration of plantation, the crown of the spruce trees was in continuous development.

Table 4. Effect of provenance and position on the slope on the diameter of spruce trees in natural and artificial regeneration in the series of experiences bifactorial type A x B x years ( 2006 - 2011)

Provenience	Position on slope		Inferiour half of the versant		Superiour half of the versant		Mean of provenance		
Fâncel			7.1	a		7.1	a	7.1	A
Gâtea			6.8	a		6.8	a	6.8	A
Lăpușna			7.3	a		7.3	a	7.3	A
Gudea			7.1	a		7.3	a	7.2	A
Sălard			7.0	a		7.1	a	7.1	A
Iod			7.1	a		7.1	a	7.1	A
Niraj			7.0	a		6.9	a	7.0	A
Remetea			4.9	b		3.6	c	4.2	B
Joseni			4.7	b		4.0	bc	4.4	B
Media / Mean			6.5	M		6.4	M		

DS/SD<sub>5%</sub> position on slope = 0.2 cm

DS/SD<sub>5%</sub> for two means of B (provenience) = 0.5 – 0.6 cm

DS/SD<sub>5%</sub> for two means A x B = 0.7 – 0.9 cm

N.B. The difference between any two values, followed by at least a common letter, is not significant

The shape of the crown was directly influenced by several factors, meaning the position on the versant, slope, consistency and stand composition.

The influence of both studied experimental factors, tree position on the slope, and their

provenience together with their interactions were analyzed concerning their influence on variance sources (table 5). The most important source of variation was identified in position on the slope, and the lowest in the interaction between experimental factors and experimental years.

Table 5. Analysis of variance for crown of spruce trees in natural and artificial regeneration, in the series of experiments type A x B x Y (2006 - 2011)

Source of variation	SS	DF	s <sup>2</sup>	F Test)	
				Versus s <sup>2</sup> <sub>E</sub>	
Total	99.67	323			
Replications	2.03	12			
Years	42.14	5	8.429	312.19**	>2.21; 3.02
A x years (A x Y)	0.50	5	0.100	3.69**	>2.21; 3.02
B x years (B x Y)	1.12	40	0.028	1.04	<1.39; 1.59
A position on slope	11.07	1	11.074	410.17**	>3.84; 6.63
B provenience	29.83	8	3.729	138.10**	>1.94; 2.51
A x B	6.83	8	0.854	31.62**	>1.94; 2.51
A x B x years (A x B x Y)	0.64	40	0.016	0.59	<1.39; 1.59
Error	5.51	204	0.027		

Because the interaction between both experimental factors had significant effects on variability of the experimental data, a synthetic presentation was needed (table 6).

The synthesis of the results shows the influence of each experimental factor together with the influence of their interactions.

Table 6. Effect of provenance and position/slope on the crown of spruce trees in natural and artificial regeneration in the series of experiences bifactorial type A x B x years (2006 - 2011)

Provenience	Position on slope	Inferiour half of the versant	Superiour half of the versant	Mean of provenience
Fâncel		2.1 a	1.3 cd	1.7 B
Gâtea		1.9 ab	1.4 c	1.6 C
Lăpușna		1.9 ab	1.3 cd	1.6 C
Gudea		1.8 b	1.3 cd	1.6 C
Sălard		1.7 b	1.1 de	1.4 D
Iod		1.9 ab	1.7 b	1.8 A
Niraj		1.3 cd	1.3 cd	1.3 D
Remetea		1.2 cd	0.9 ef	1.0 E
Joseni		0.8 f	0.9 ef	0.8 F
Media / Mean		1.6 M	1.2 N	

DS/SD<sub>5%</sub> for two means of A(position on slope) = 0.1

DS/SD<sub>5%</sub> for two means of B (provenience) = 0.2

DS/SD<sub>5%</sub> for two means A x B = 0.3

N.B. The difference between any two values, followed by at least a common letter, is not significant

The measurement of the needles was performed on annually, during studied time period, 2006 – 2011, under influence of the both considered experimental factors, meaning the position of the trees on the versant and their provenience.

The variance sources determined for each experimental factor, and also for their interaction are presented. The most important source of variance was identified in tree provenience, and the lowest in the interaction between the experimental factors and the experimental years (table 7).

Table 7. Analysis of variance for needle length of spruce trees in natural and artificial regeneration, in the series of experiments type A x B x Y (2006-2011)

Source of variation	SS	DF	s <sup>2</sup>	F Test)	
				Versus s <sup>2</sup> <sub>E</sub>	
Total	12.44	323			
Replications	0.42	12			
Years	1.61	5	0.321	12.48**	>2,21; 3.02
A x years (A x Y)	0.11	5	0.022	0.85	<2.21
B x years (B x Y)	1.75	40	0.044	1.70**	>1,39; 1.59
A position on slope	0.01	1	0.007	0.27	<3.84
B provenience	2.75	8	0.343	13.34**	>1.94; 2.51
A x B	0.05	8	0.007	0.25	<1,94
A x B x years (A x B x Y)	0.50	40	0.013	0.49	<1,39
Error	5.25	204	0.026		

Because the interaction between both experimental factors had significant effects on the variability of the experimental data, the synthesis of the results was presented (table 8).

Table 8. Effect of provenance and position/slope on the needle length of spruce trees in natural and artificial regeneration in the series of experiences bifactorial type A x B x years (2006 - 2011)

Provenance	Position on slope	Inferiour half of the versant	Superiour half of the versant	Mean of provenance
Fâncel		1.9 ab	1.9 ab	1.9 B
Gâtea		2.0 a	1.9 ab	2.0 A
Lăpușna		1.9 ab	1.9 ab	1.9 B
Gudea		1.9 ab	1.9 ab	1.9 B
Sălard		1.9 ab	2.0 a	1.9 B
Iod		1.9 ab	1.9 ab	1.9 B
Niraj		1.8 bc	1.9 ab	1.9 B
Remetea		1.7 c	1.7 c	1.7 C
Joseni		1.7 c	1.7 c	1.7 C
Media / Mean		1.9 M	1.9 M	

DS/SD<sub>5%</sub> for two means of A(position on slope) = 0.1

DS/SD<sub>5%</sub> for two means of B (provenance) = 0.2

DS/SD<sub>5%</sub> for two means A × B = 0.3

N.B. The difference between any two values, followed by at least a common letter, is not significant

According to data presented in table 8, the biggest length of the stalks was identified in spruce trees from Gâtea with average value of 2.0 cm, followed with not significant differences by needles length of the trees with provenance from Fâncel, Lăpușna, Gudea, Sălard, Iod, Niraj, with values of 1.9 cm, that may be emphasized as average values, followed by the lowest averages of 1.7 cm identified in spruce trees from Remetea și Suseni. Between these last values and the others significant differences were recorded

The data from table 8 emphasize the effects of the interaction between both studied factors, meaning position on the versant and provenance, on the length of the needles from the lujeri.

The increase of the annual stalks of the branches from the crown determined the development of the trees' crown and themselves, too.

This analyze was performed taking into account both experimental factors, meaning the position on the versant and provenance, together with the interaction between above mentioned factors.

The data concerning the influence of these experimental factors and their influence on analyzed traits expressed as source of variance (table 9), show that the most important source of variance was tree provenance, and the lowest, similarly with the other mentioned traits in the interaction experimental factors and experimental year (table 9).

Considering the interaction between the experimental factors, we find that they had significant influences on the variability of the experimental data (table 10).

The synthesis of these results show the amplitude of these influences.

Table 9. Analysis of variance for stalks of spruce trees in natural and artificial regeneration. in the series of experiments type A  $\times$  B  $\times$  Y (2006-2011)

Source of variation	SS	DF	s <sup>2</sup>	F Test)	
				Versus s <sup>2</sup> <sub>E</sub>	
Total	1697.10	323			
Replications	9.85	12			
Years	293.17	5	58.633	26.67**	>2.21; 3.02
A x years (A $\times$ Y)	16.14	5	3.229	1.47	<2.21
B x years (B $\times$ Y)	210.43	40	5.261	2.39**	>1.39; 1.59
A position on slope	3.93	1	3.934	1.79	<3.84
B provenience	651.25	8	81.406	37.03**	>1.94; 2.51
A x B	3.06	8	0.382	0.17	<1.94
A x B x years (A $\times$ B $\times$ Y)	60.77	40	1.519	0.69	<1.39
Error	448.50	204	2.199		

Table 10. Effect of provenance and position on the slope on the stalks of spruce trees in natural and artificial regeneration in the series of experiences bifactorial type A x B x years (2006 - 2011)

Provenance	Position on slope		Inferiour half of the versant		Superiour half of the versant		Mean of provenance	
Fâncel			11.5	a	11.2	a	11.4	A
Gâtea			12.4	a	12.0	a	12.2	A
Lăpușna			11.4	a	11.1	a	11.2	A
Gudea			11.7	a	11.6	a	11.7	A
Sălard			11.5	a	11.0	a	11.2	A
Iod			11.6	a	11.4	a	11.5	A
Niraj			12.1	a	11.7	a	11.9	A
Remetea			8.1	b	8.2	b	8.1	B
Joseni			8.4	b	8.4	b	8.4	B
Media / Mean			10.9	M	10.7	M		

DS/SD<sub>5%</sub> for two means of A(position on splope = 0.8

DS/SD<sub>5%</sub> for two means of B (provenience) = 1.7 – 2.0

DS/SD<sub>5%</sub> for two means A  $\times$  B = 2.4 – 3.1

N.B. The difference between any two values, followed by at least a common letter, is not significant

#### 4. Conclusions

Significant differences were identified in development and restoring of the areas anthropically and enthropically affected (consistency, composition, acheivement of the natural fundamental type of forest) from the studied forests, administered by forest offices or not administered areas, whatever ownership form or property.

Significant differences were also identified concerning the phenotipical variability of the

reasearched traits (height, diameter, crown, stalks, needles) in terms of provenience nd position on versant.

From our analyzes resulted that in areas administered by forest offices it was proposed and promoted the natural fondamental type of forest. In not administered areas the forests, the fondamental type of forest could not be promoted and put into practice and duet o this reason, it is considered that

those forest would became derivate forests with inferior type of productivity.

## References

[1] Enescu V., 2002, Silvicultura durabilă, Editura Agris, București

[2] Milescu I., 2006, Cartea silvicultorului, Editura Petru Maior, Reghin

[3] Popa I., 2007, Managementul Riscului la Doborâturi produse de vânt, Editura tehnică silvică, București

[4] Șofletea N., 2007, Dendrologie, Editura Transilvania, Brașov

[5] Târziu D., 2006, Pedologie, Editura Silvodel, Brașov

[6] Untaru E., 1993, Ameliorarea terenurilor degradate, Editura Tehnică Silvică București

[7] Vlad I., L. Petrescu, 1977, Cultura molidului în România, Editura Ceres, București